

Applicant : Zhimin Liu, Mark S. Wang, and Jingyu Xu Attorney's Docket No.: 13854-032001 / OPLINK-0106
Serial No. : 09/899,481
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In the claims:

Please amend the claims as follows:

1. Cancelled.
2. Cancelled.
3. (Currently Amended) The four-port loop optical circulator of claim 2 wherein: A four-port loop optical circulator comprising:

a first, a second, a third and a fourth optical port for receiving an optical beam
therein;

a plurality of optical components for guiding a beam received from said first port
to project from said second port, for guiding a beam received from said second port to project
from said third port, for guiding a beam received from said third port to project from said fourth
port, and for guiding a beam received from said fourth port to project from said first port; and
wherein said plurality of optical components includes

a walk-off crystal for generating a vertical optical path displacement for a vertical
polarized optical beam and for passing a horizontally polarized optical beam therethrough
maintaining a same optical path,

a vertical displacement means for shifting an optical path along a vertical
direction with a predefined vertical displacement for an optical beam transmitted with a
particular polarization, and

wherein said vertical displacement means is coupled to said walk-off crystal for
guiding a beam received from said fourth port to project from said first port, and

said plurality of optical components further includes a first birefringent crystal
disposed on a left-hand side of said walk-off crystal for generating a first ordinary beam and a
first extra-ordinary beam and a second birefringent crystal disposed on a right-hand side of said
walk-off crystal for generating a second ordinary beam and a second extra-ordinary beam.

4. (Currently Amended) The four-port loop optical circulator of claim 2 wherein:
said plurality of optical components further includes a first polarization rotation
means disposed on said left-hand side of said walk-off crystal for generating a first state of
polarization (SOP) for said first ordinary beam and said first extra-ordinary beam to project to

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said walk-off crystal and a second polarization rotation means disposed on said right-hand side of said walk-off crystal for generating a second SOP for said second ordinary beam and said second extra-ordinary beam to project to said walk-off crystal wherein said first SOP is orthogonal to said second SOP.

5. Cancelled.

6. (Currently Amended) The four-port loop optical circulator of claim 2 3 wherein:
said vertical displacement means further comprising a polarized beam splitter for reflecting an optical beam with said particular polarization substantially along a vertical direction for generating said predefined vertical displacement.

7. (Previously Amended) The four-port loop optical circulator of claim 6 wherein:
said vertical displacement means further comprising a right angle prism disposed at said predefined vertical displacement away from said polarized beam splitter, said right angle prism reflecting said optical beam with said particular polarization projected from said polarized beam splitter for transmitting said optical beam with said particular polarization substantially along a horizontal direction.

8. (Previously Amended) The four-port loop optical circulator of claim 7 wherein:
said vertical displacement means further comprising a first set of half wave plates for changing a state of polarization (SOP) of a beam by 90 degrees toward a first angular direction to a polarized beam splitter (PBS)-incident SOP to allow a beam to pass through or reflected from said PBS depending on said PBS-incident SOP then another set of half wave plates to rotate said SOP of said beam by 90 degrees toward a second angular direction opposite to said first angular direction.

9. (Currently Amended) A switchable The four-port optical loop circulator of claim 3, further comprising:

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~~a loop optical circulator having N ports each being labeled as port K with K chosen consecutively from 1 to N, the loop optical circulator operable to guide a beam received from port K to port K+1 if K is less than N and operable to guide a beam received from port N to port 1, where N is an integer that is at least three and K is an integer that is at least 1; and~~

~~an optical switching means disposed in an optical path of the loop circulator for to switch an order of circulation switching optical transmission paths of said loop optical circulator.~~

10. (Original) The switching means of claim 9 wherein:

 said switching means comprising a set of latched Faraday rotators surrounded by an electromagnetic pulse means for controlling a rotation direction of said latched Faraday rotators.

11. (Original) The switching means of claim 9 wherein:

 said switching means further comprising electrically controlled half wave plates composed of electro-optic materials.

12. (Previously Amended) The switching means of claim 9 wherein:

 said switching means further comprising an electrically controlled half wave plate composed of liquid crystals.

13. (Previously Amended) The switching means of claim 9 wherein:

 said switching means further comprising an electrically controlled in/out rhomb prism.

14. (Previously Amended) The switching means of claim 9 wherein:

 said switching means further comprising an electrically controlled in/out DOVE prism.

15. (Currently Amended) A four-port loop optical circulator comprising:

 a first, a second, a third and a fourth optical ports for receiving optical beam therein;

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a plurality of optical components for guiding a beam received from said first port to project from said second port, for guiding a beam received from said second port to project from said third port, for guiding a beam received from said third port to project from said fourth port, and for guiding a beam received from said fourth port to project from said first port; and wherein said plurality of optical components includes

a walk-off crystal for generating a vertical optical path displacement for a vertical polarized optical beam and for passing a horizontally polarized optical beam therethrough maintaining a same optical path,

a vertical displacement means for shifting an optical path along a vertical direction with a predefined vertical displacement for an optical beam transmitted with a particular polarization, and

wherein said vertical displacement means is adapted to transmit or receive said vertical polarized optical beam from said walk-off crystal, including vertically displacing the beam received from said fourth port and not vertically displacing the beam received from said third port or first port.

16. (Previously Added) The four-port loop optical circulator of claim 15 wherein:
said plurality of optical components further includes a first birefringent crystal disposed on a left-hand side of said walk-off crystal for generating a first ordinary beam and a first extra-ordinary beam and a second birefringent crystal disposed on a right-hand side of said walk-off crystal for generating a second ordinary beam and a second extra-ordinary beam.

17. (Previously Added) The four-port loop optical circulator of claim 15 wherein:
said plurality of optical components further includes a first polarization rotation means disposed on said left-hand side of said walk-off crystal for generating a first state of polarization (SOP) for said first ordinary beam and said first extra-ordinary beam to project to said walk-off crystal and a second polarization rotation means disposed on said right-hand side of said walk-off crystal for generating a second SOP for said second ordinary beam and said second extra-ordinary beam to project to said walk-off crystal wherein said first SOP is orthogonal to said second SOP.

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18. (Previously Added) The four-port loop optical circulator of claim 15 wherein:
said vertical displacement means further comprising a polarized beam splitter for reflecting an optical beam with said particular polarization substantially along a vertical direction for generating said predefined vertical displacement.
19. (Previously Added) The four-port loop optical circulator of claim 18 wherein:
said vertical displacement means further comprising a right angle prism disposed at said predefined vertical displacement away from said polarized beam splitter, said right angle prism reflecting said optical beam with said particular polarization projected from said polarized beam splitter for transmitting said optical beam with said particular polarization substantially along a horizontal direction.
20. (Previously Added) The four-port loop optical circulator of claim 19 wherein:
said vertical displacement means further comprising a first set of half wave plates for changing a state of polarization (SOP) of a beam by 90 degrees toward a first angular direction to a PBS-incident SOP to allow a beam to pass through or reflected from said PBS depending on said PBS-incident SOP then another set of half wave plates to rotate said SOP of said beam by 90 degrees toward a second angular direction opposite to said first angular direction.
21. (New) The four-port optical loop circulator of claim 15, further comprising:
an optical switching means disposed in an optical path of the loop circulator to switch order of circulation of said loop optical circulator.
22. (New) A four-port optical loop circulator comprising:
a first, a second, a third and a fourth optical ports for receiving an optical beam therein;
a plurality of optical components for guiding a beam received from said first port to project from said second port, for guiding a beam received from said second port to project

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from said third port, for guiding a beam received from said third port to project from said fourth port, and for guiding a beam received from said fourth port to project from said first port; and wherein said plurality of optical components includes

a walk-off crystal for generating a vertical optical path displacement for a first polarized optical beam and for passing a second polarized optical beam therethrough maintaining the same optical path,

a polarization beam splitter ("PBS") coupled to the walk-off crystal and configured to reflect a beam received at a lower optical path from said fourth port along a vertical direction for generating a predefined vertical displacement; and

a right angle prism disposed at the predefined vertical displacement from the PBS and configured to reflect an optical beam received from the PBS in a substantially horizontal direction along an upper optical path to the walk-off crystal.

23. (New) The four-port optical loop circulator of claim 22, further comprising:

a first half wave plate for changing a state of polarization ("SOP") of light from a first SOP to a second SOP to allow light to be reflected by the PBS; and

a second half wave plate for changing the SOP back to the first SOP after reflection by the PBS.